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THE REASON WHY THE NECK OF THE FEMUR DOES NOT BREAK.

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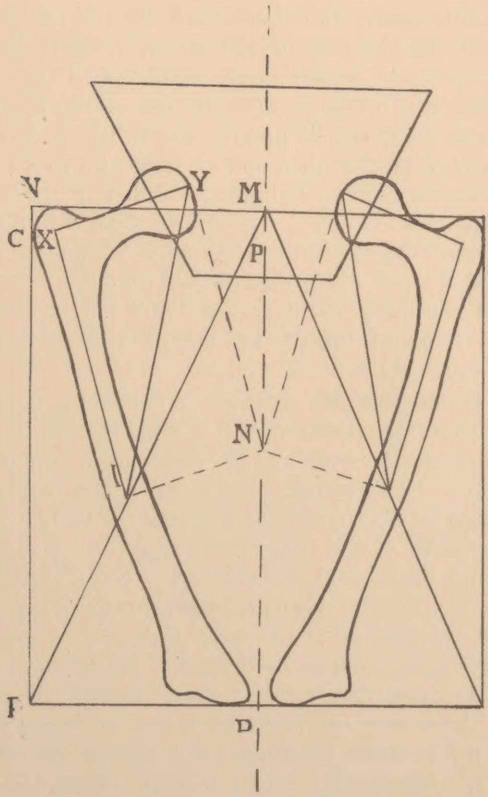
THE clinical study of fractures of the femur due to indirect violence shows a preponderance of breakage within a given area. When we look at the femur as a whole, we are impressed with the idea that the part that would appear most liable to suffer this accident is the neck. The distance of the head from the shaft, by its obtuse angle, would, at the first glance, lead us to suppose this to be the weakest point. But Nature has recognized this, and has made every effort to strengthen it. The arrangement of columns of osseous tissue gives unusual support, and lessens the violence of shock. This arrangement has been accepted as the reason why fractures are not common at the neck. When fractures occur at this point they are confined principally to the declining stage of life, and even then this is, no doubt, due to osseous degeneration and consequent change.

Granting that every provision has been made to strengthen the neck, can we, on careful examination of the femur, say that it is in any other and better manner enabled to hold the trunk? Will not a

tubular column stand more direct pressure than any mechanical apparatus constructed on the same principle as the neck of the femur, providing the same comparative size is maintained?

Nature has made no part of the economy by chance. Perfection was reached by means extending over long ages. The very angle which the neck of the femur takes is the keynote in the argument against itself as a factor, as far as strength is concerned. It is on the ground that all parts of the body are based on definite and distinct laws that I propose to demonstrate by a problem in mathematics that fractures of the femur taking place in the shaft, and not in the neck, are governed by distinctive laws. It is not so much a question of the strength of any part of the bone as it is that of the impact of forces at a given spot.

An examination of the annexed figure shows the presence of two major rectangles and four right-angled triangles, and two minor rectangles and four right-angled triangles. One side of the major rectangles is made by the line of the center of gravity. The base is formed by a horizontal line extending from great trochanter to great trochanter; then another line is dropped from the outer side of the great trochanters, parallel with the line passing vertically through the center of gravity. These are joined by a horizontal line, parallel with the base, through the knee-joints. This gives the two major rectangles. Then starting at M we carry a line to F, which divides the rectangle into two right-angled triangles. If we now draw a line through the center (Y) of the head of the


V
Y
M
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femur, we find that it strikes the shaft of the femur on a level with the neck at its junction with the shaft (X). This line is carried to the center of the axis of the femur, and then down its length to the point of bisection of the femur, I, made by the hypothenuse of the major right-angled triangle. Then carry a line parallel with the base to N, which strikes the center of gravity, one of the sides of the major rectangles, then up to Y, parallel with X I, and we have a rectangle similar to either of the major rectangles. Then a line drawn from Y to I gives the hypothenuse of two right-angled triangles, both similar to the major right-angled triangles.

The value of the figure lies in the modification of the force of impact by the presence of certain definite laws.

The patient falls either on feet or knees, the force in the illustration being a combination of the weight of the body and the resistance of the object struck. A force travelling to the center of gravity would be the sum of the weight of the body and the resistance of the object, and therefore the impact at the base would be as the sum; consequently the neck of the femur would break, but the presence of the hypothenuse of the major right-angled triangles meeting at the base modifies the impact according to the rule that governs force applied obliquely. In the present case the force is applied in the direction F P, under the angle F P C, against the surface M V. Resolve F P into F C perpendicular to M V, and F D parallel with it, then F C will be the absolute effect of the force, and F P — F C is the loss. To prove the value of this, which applies to the body as

a whole, the presence of the same angle in the minor triangle, in which the force is I Y, demonstrates it when applied to the femur proper; consequently, instead of the neck of the femur having to resist the whole force, it is modified, and the explosion or resultant takes place at another point.

The place of explosion is proved by the law: "Two forces not parallel, and applied at different points, may have a resultant, if they lie in the same plane. It is found by extending the lines of direction until they intersect."

The hypothenuse F P of the major right-angled triangle, by the direction of the force, is applied at the center of the base-line M. This is the force applied to the body as a whole. The point of application of the force in the minor angle is at the head of the femur. These forces are not parallel, but on the same plane, the point of application being different. Therefore, the line of the minor triangles, Y I, intersects the line of the major triangles, F P, at the middle of the femur; consequently, the resultant of the force is at this point, and the femur breaks at or about the middle of the shaft.

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